King County Conveyance System Improvement Project
Executive Summary

The Conveyance System Improvement Project's Hidden Lake Service Area reports describe current and future wastewater planning issues and solutions for King County Wastewater Treatment Division (KC WTD) facilities located in the western part of the City of Shoreline. The Hidden Lake Service Area (Service Area) includes all sewered areas that drain to the KC WTD Hidden Lake Pump Station and all downstream neighborhoods that drain to the Boeing Creek Trunk and Richmond Beach Pump Station. Changes to the size and operations of the Hidden Lake Pump Station designed to fix its problems will also affect these downstream facilities.

Three sewer agencies own, operate and maintain wastewater conveyance facilities in the Service Area: the Shoreline Wastewater Management District (WMD), the Highland Sewer District (SD) and KC WTD. The Shoreline WMD and Highlands SD are responsible for collecting and transferring wastewater to KC WTD. KC WTD conveys local agency flows through a combination of force main and gravity sewer to the Edmonds Wastewater Treatment Plant for treatment and discharge. Figure 1 shows the extent of the Service Area, local agency boundaries, and major facilities.

The KC WTD facilities in the Service Area are the Hidden Lake Pump Station, the Boeing Creek Trunk and the Richmond Beach Pump Station. As shown in Figure 1, the Boeing Creek Trunk begins at the discharge of Shoreline WMD's 1,300-acre Basin 14. The trunk runs by gravity to the Hidden Lake Pump Station. The Hidden Lake Pump Station discharge is conveyed by force main and then by gravity through the Boeing Creek Trunk to the Richmond Beach Pump Station, and then by force main and gravity to the Edmonds Treatment Plant.

Background

The Boeing Creek Trunk and Hidden Lake Pump Station were built in the early 1960's. At that time, the newly formed Ronald Sewer District (now Shoreline WMD) was in the process of developing a sewer system. The Highlands SD was collecting wastewater from the 100 homes in the Highlands and discharging to Puget Sound. Over the past 40 years, the Service Area population has grown to 20,000, almost all of which is served by sanitary sewers. As the sewered population has grown and the sewer infrastructure has aged, a number of wastewater conveyance concerns have arisen:

- The pumping capacity of the Hidden Lake Pump Station and the hydraulic capacity of the Boeing Creek Trunk are insufficient to convey peak wet weather flows to the KC sanitary sewer standard of one overflow per 20 years (Figure 2). These capacity limitations result in overflows from the Hidden Lake Pump Station wet well and downstream at Boeing Creek Trunk manhole 7A (see Figure 1 for overflow manhole location). The electrical, instrumentation and control, and mechanical equipment in the Hidden Lake Pump Station

are nearing the end of their useful lives. Mechanical failures result in overflows from the pump station wet well. Overflows due to capacity limitations and/or mechanical failures occur an average of three times per year at the Hidden Lake Pump Station.

- Sulfide-related corrosion and odors have been a problem at the Hidden Lake Pump Station and in the downstream piping. In 1988, sections of the Boeing Creek Trunk showing the most advanced corrosion were rehabilitated with HDPE sliplining. The sliplining reduced the inner diameters and hydraulic capacity of the rehabilitated sections of pipe by an estimated 1 to 3 mgd (see Figure 2, *Original Capacity* and *Current Capacity* for pre- and post-sliplining capacities).

- There have been backups into the local system from the Boeing Creek Trunk. Several houses located upstream of the Hidden Lake Pump Station experienced backups due to the limited capacity at the pump station. In 1997, these homes were disconnected from the Boeing Creek Trunk and rerouted via Shoreline WMD PS No. 5 to prevent basement flooding. In that same year, a backflow preventor valve was supplied by KC WTD and installed in the local sewer on NW 188th Street to eliminate further backups in this neighborhood downstream of the Hidden Lake Pump Station that same year.

The Service Area is largely developed and the future growth rate is expected to continue at a modest rate of less than one percent annually. Future growth will occur as vacant lots are filled in and neighborhoods adjacent to commercial corridors are rezoned to allow for higher density, multi-family housing. Wastewater planning for the Service Area is driven more by the need to address the immediate concerns of alleviating the operational difficulties at the Hidden Lake Pump Station, managing peak wet weather flows while anticipating the effects of future sewer deterioration, and controlling odor, rather than accommodating future growth. Any wastewater service improvement plan must also include enough flexibility to work with the results of the North Plant siting study and the KC regional infiltration and inflow (I/I) study. These projects will help refine the projected peak design flow, the costs and feasibility of I/I reduction, and the most efficient means of wastewater routing.

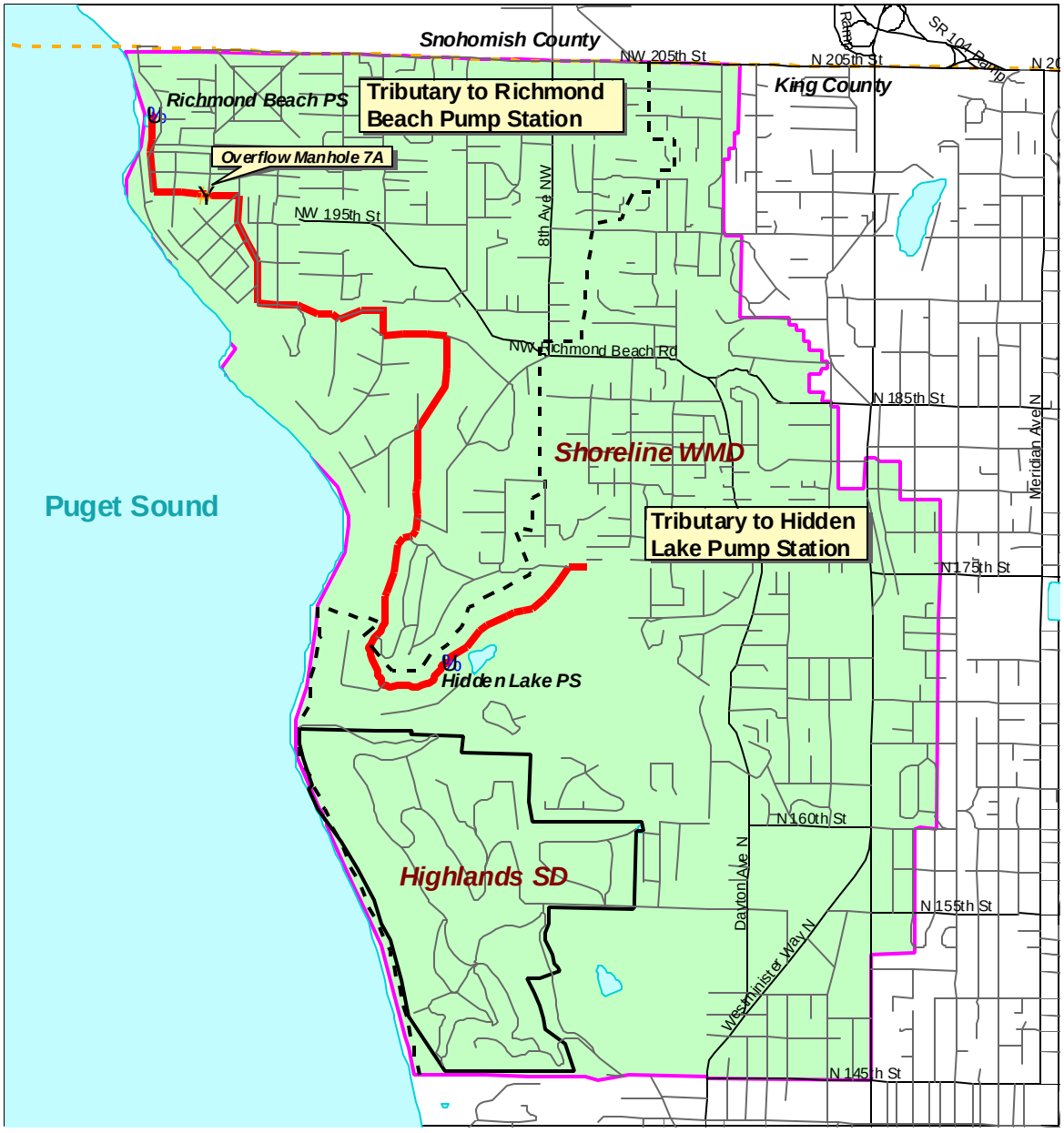


Figure 1: Hidden Lake Service Area

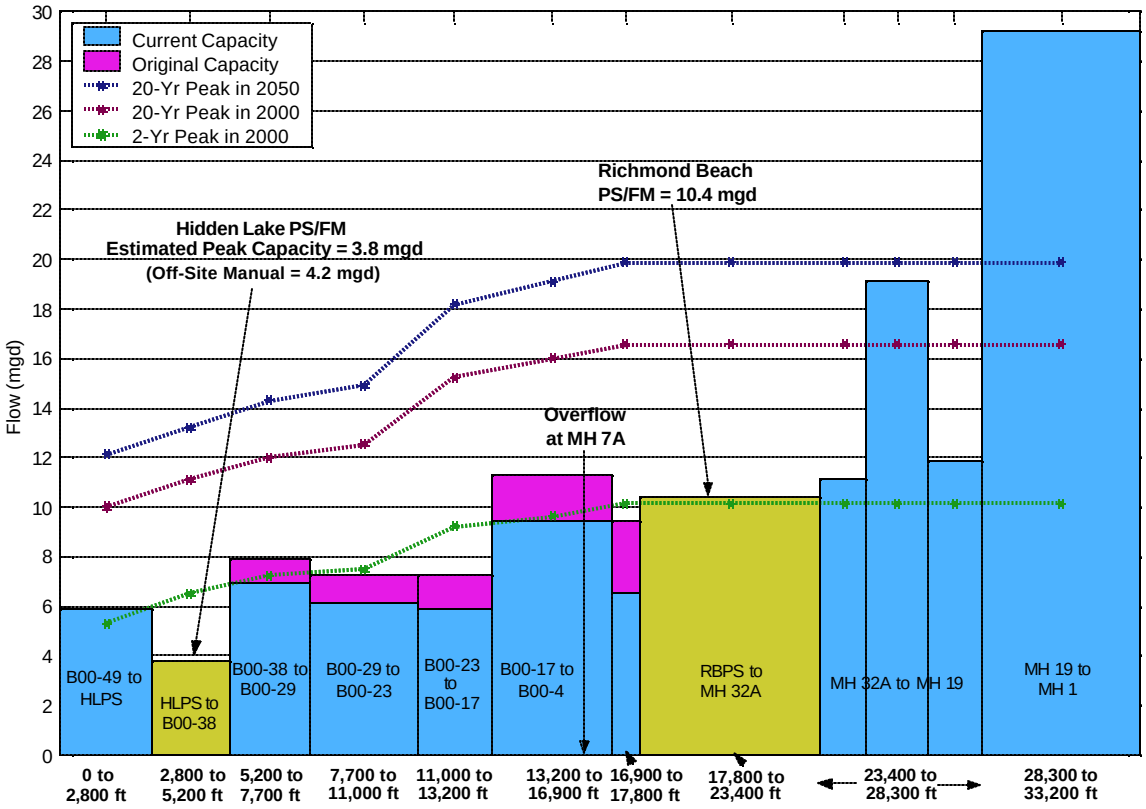


Figure 2. Peak flows and conveyance capacity in the Boeing Creek Trunk.

Conveyance System Improvement Alternatives

The CSI project team developed 15 alternatives and sub-alternatives for reducing the number of Service Area overflows to the King County standard of once per 20 years. All of the alternatives include provisions for replacing or retrofitting the Hidden Lake Pump Station and thus addressing the reliability and odor control problems at the station. The alternatives, which are fully described in Task Memos 240 and 250, are composed of combinations of the following elements:

1. Upgrading the capacity of the KC WTD pump stations and sewers along present routing.

2. Using storage to attenuate peak flows and control system overflows.

3. Diverting peak wet weather flows away from the Boeing Creek Trunk.

4. Targeted infiltration and inflow (I/I) reduction

The description of each alternative addresses replacement, upgrading, and/or construction of new King County facilities. Construction factors, planning and permitting issues, and impacts on other King County facilities also were described and planning level cost estimates

were developed. Wherever new facilities were required, they were sized using the flow projections provided by KC WTD for the year 2050. The KC WTD flow projections were based on population forecasts (used to compute sanitary base flow) and the results of the calibrated KC WTD hydrologic I/I model.

During the process of developing alternatives, the CSI project team engaged King County staff for evaluation and input. The following sections describe the key elements of the various alternatives and the input of the CSI project team and KC Staff (see Table 1 for a summary of the results).

The Shoreline WMD was consulted throughout this planning study. The District's review included draft reports for Task 210, 220, 230, 240, 250 260, and an early proposed draft 310. The District also attended meetings in November 1999 and again in April 2000. The final Task 250 and 260 reports include additional information and appropriate clarification as provided by the District their its engineer's May 5, 2000, letter to King County.

Task 240 Review

The CSI project team and KC WTD staff met at a project workshop on August 19, 1999, to discuss the nine alternatives and sub-alternatives presented in the Task 240 report. All agreed that paralleling the Boeing Creek Trunk (Alternative A) or incorporating tank storage into the system (Alternatives B1 and B2) would not be the best choices for a number of constructability and operations reasons. For example, County staff was concerned with the difficulties associated with constructing a parallel sewer through the Innis Arden neighborhood due to the number of existing buried utilities. KC staff also raised operations and maintenance concerns regarding storage.

The CSI project team and KC staff similarly agreed that the selection of diversion alternatives, collectively known as Alternative D, were generally not feasible, again for a variety of technical and/or operations reasons. Alternatives D1 and D2 were not considered feasible because each would redirect peak wet weather flows into sections of the KC WTD conveyance system that already have conveyance capacity limitations (D1 – Lake Ballinger Pump Station; D2 – North Lake City Trunk/Matthews Park Pump Station). There are hydraulic advantages of constructing a sewer along the waterfront (Alternative D3), but workshop participants were concerned about the potential environmental impacts of constructing a pipeline down to the bluff and along the waterfront. (A subsequent environmental review in Task 250 identified an unacceptable number of difficult permitting issues with Alternative D3.) The number of receiving pits required to follow the public right of way along NW 175th Street and the potential inconvenience to local residents were noted shortcomings of tunnel Alternative D4.

The workshop consensus was that Alternative C2 was the most feasible alternative. Alternative C2 would include a 13.2 mgd pump station located at the beginning of the Boeing Creek Trunk that would divert peak wet weather flows in a new force main/gravity sewer northward towards the Edmonds Wastewater Treatment Plant (or to the planned North Treatment Plant, once it is operating). The diversion would be large enough to avoid

construction along the existing trunk. The Hidden Lake Pump Station would be rebuilt at a similar size with bidirectional pumping so that dry weather flows could be sent to the Boeing Creek Trunk to aid in operation of the inverted siphon and Richmond Beach Pump Station.

Task 250 Review

The project team held a meeting with KC staff on December 2, 1999, to discuss refinements to what was then the working alternative, Alternative C2 (diversion pump station and sewer). County staff felt all possible improvements had not been examined and that given the level of capital expense in Alternative C2, additional alternatives should be developed. There was also direction to examine a phased project implementation that could successfully coordinate with ongoing King County projects in the area, and level capital costs. A total of five additional alternatives were evaluated and compared against Alternative C2. Of these, Alternatives D8 and D9, which each incorporate phased construction and a combination of overflow control strategies, were considered the most feasible. The consultant team set out to develop a broader set of phased/combination alternatives to present to KC Staff in order to arrive at a working solution to pass along to the County's Capital Improvement Projects group. Table 1 gives a synopsis of each of the alternatives and sub-alternatives considered, along with conclusions about their feasibility.

Table 1. Summary of Hidden Lake alternative analysis

Alt. No.	Description	Team Action	Reason
A	Capacity upgrades using existing alignment	Modified	Complete upgrade rejected because of construction difficulties due to existing buried utilities in right-of-way, but some segments might be upgraded without utility complications
B1	2.4 MG storage at Hidden Lake Pump Station	Rejected	Tank siting problems, higher cost, higher O&M requirements
B2	1.5 MG storage at Richmond Beach Pump Station	Rejected	Does not avoid construction difficulties noted for Alt. A; probability of piling to support tank drives up cost
C1	Diverting flow from Hidden Lake PS with 9.7 mgd pump station	Rejected	Higher cost than C2 because it requires a new pump station plus upsizing Boeing Creek facilities
C2	Diverting flow from Hidden Lake PS with 13.2 mgd pump station	Working Alternative	Lowest cost alternative because a larger pump station eliminates need to upgrade Boeing Creek facilities
D1	Pump flow to Lake Ballinger PS	Rejected	Transfers wet weather flows to other maximized/optimized King County conveyance facilities
D2	Pump to North Lake City Trunk and Matthews Park basin	Rejected	Transfers wet weather flows to other maximized/optimized King County conveyance facilities
D3	New sewer over bluff and along shoreline to Edmonds WWTP	Environ. Evaluation	Gravity option a plus, but environmental concerns (ESA, sensitive areas) limit viability
D4	Tunnel new pressure sewer under NW 175th St.	Rejected	Tunnel would be long, deep and have many turns, driving up costs
D5	Use old primary clarifiers at Richmond Beach for storage	Rejected	Storage capacity in clarifiers Insufficient to significantly lower costs relative to Alts. A & B2
D6	Direct part of Basin 14 flows out of Service Area	Rejected	Reduces size of Hidden Lake pump station, but requires long, deep directional drilling
D7	Tunnel storage and conveyance	Rejected	Would require difficult tunnel easements under private property; limiting tunnel to public r-o-w not feasible because of number of street turns
D8	Short term solutions to reduce overflows until North Treatment Plant built	Working Alternative	Controlling 2 year storm requires significant investment now with greater investment required later, but underutilized facilities are avoided and flexibility is maintained
D9	Phase construction on as-needed basis, waiting to see how regional I/I program, North Treatment Plant impact basin	Working Alternative	Can be used with working alternative C or any other alternative to eliminate costs that might not be needed if these programs reduce Hidden Lake problems

Working Alternative

A set of phased/combination alternatives was presented to KC staff at a decision workshop held on March 16, 2000. The objective of the workshop was to specify a working alternative that would meet the immediate upgrade needs at the Hidden Lake Pump Station, reduce the number of sanitary overflows in the service area, and achieve the KC 20-year storm control level.

The working alternative will initially retrofit or replace the Hidden Lake Pump Station to achieve a peak pumping capacity of 5.5 mgd, and parallel or replace a total of 6,400 lineal feet of the most capacity limited sections of the Boeing Creek Trunk[1]. Increasing the pumping capacity at Hidden Lake and removing the bottlenecks in the Boeing Creek Trunk would allow the full capacity of the Richmond Beach Pump Station to be used. This combination of upgrades will reduce the number of storm related overflows to approximately one every 2 years. Providing 0.5 MG of storage upstream of the Hidden Lake Pump Station will, according to the best available flow information, further reduce the number of storm related overflows to one every 4 to 5 years. After the North Plant siting and regional I/I programs are completed (assumed 2005), the level of control will be brought to the KC standard of one overflow every 20 years by I/I reduction, additional storage and/or construction of a diversion pump station and sewer directed away from the Boeing Creek Trunk. The final flow projections developed during the regional I/I study, and the North Plant location would be used for final sizing and alignment of the new facilities.

The paralleling/replacement work is planned for the pipe segments between manholes B00-29 to B00-17 and B00-7 to the Richmond Beach Pump Station (Figure 3). These pipes are shown in Figure 2 as not having enough capacity to pass the 2-year peak flow. Wherever it is feasible, replacing capacity limited pipes should supersede the County's planned corrosion-related rehabilitation of the Boeing Creek Trunk.

The CSI project team performed a preliminary siting analysis for the 0.5 MG of storage facility. One potential location for offline, gravity in/out storage is along NW 175th Street, between 6th and 10th Avenues NW at the upstream end of the Boeing Creek Trunk. A storage tank and associated piping could be located on a section of the vacant property on the northwest corner of NW 175th Street and 6th Avenue NW. Alternatively, a 1,450 lineal foot, 8-foot diameter offline pipe could be installed from B00-49 to B00-42 to provide 0.5 MG of storage upstream of the Hidden Lake Pump Station (Figure 3). The location and alignment of storage elements must be examined during project predesign.

[1] Increasing the capacity of the Hidden Lake Pump Station from 3.8 mgd to 5.5 mgd and upgrading the downstream conveyance brings the capacities of these facilities in line with the Richmond Beach Pump Station. Both upgrades are essential to reducing overflows until the 20-year control plan is implemented. Increasing the capacity of the trunk sewer will reduce overflows at manhole 7A (located near the Richmond Beach Pump Station; see Figure 1 for manhole location). Rebuilding or retrofitting the Hidden Lake Pump Station with a 5.5 mgd capacity will reduce the frequency of overflows from the wet well, while limiting force main velocities to 8 ft/s. All facilities would have sufficient capacity for the unattenuated 2-year peak flow.

This selected system alternative provides:

- Short-term improvements that will reduce the frequency of overflows and long-term improvements will incorporate better flow projections and routing information.
- Time for the regional I/I program to work. Rather than accepting all flows from the component agencies, the County can work with these agencies to promote I/I reduction and system maintenance to reduce peak flows.
- Expanded capacity in the Boeing Creek Trunk that will allow the Richmond Beach Pump Station to be fully utilized.

Table 2 and Figure 4 show cost estimates for both phases of the working alternative. The phase II costs assume additional facilities are a diversion pump station and sewer sized to provide enough additional capacity to convey the 20-year peak flow.

Table 2. Working Alternative cost estimate

	Cost (millions; ENR Seattle CCI =7,000)
Project Phase I:	
Replace Hidden Lake PS at 5.5 mgd	3.3[a]
Parallel/Replace 6,400 ft of Boeing Creek Trunk (brings control to 2-year level)	4.0[a,b]
Add 0.5 MG of storage upstream of Hidden Lake PS (brings control to 4 to 5-year level)	2.8[a]
Add KC allied costs (assume +50%)	+50%
Phase I Total	**15.1**
Project Phase II:	
Add facilities (brings control to 20-year level; KC allied costs included)[c]	20.5
Total Project Cost:	**35.6**

a. Brown and Caldwell estimates include 10% contractors O&P, 10% mob/demob, 30% contingency, 8.6% sales tax, and 35% for design. These costs assume the Hidden Lake Pump Station is replaced, not retrofitted.

b. Construction costs in the congested area downstream of the Hidden Lake Pump Station have been increased by 50% to reflect the potential difficulties of design and construction in areas with large numbers of buried utilities.

c. Assumes diversion pump station and sewer sized to bring control to 20-year level with no I/I reduction, and a 7% increase in I/I per decade for 3 decades through 2030.

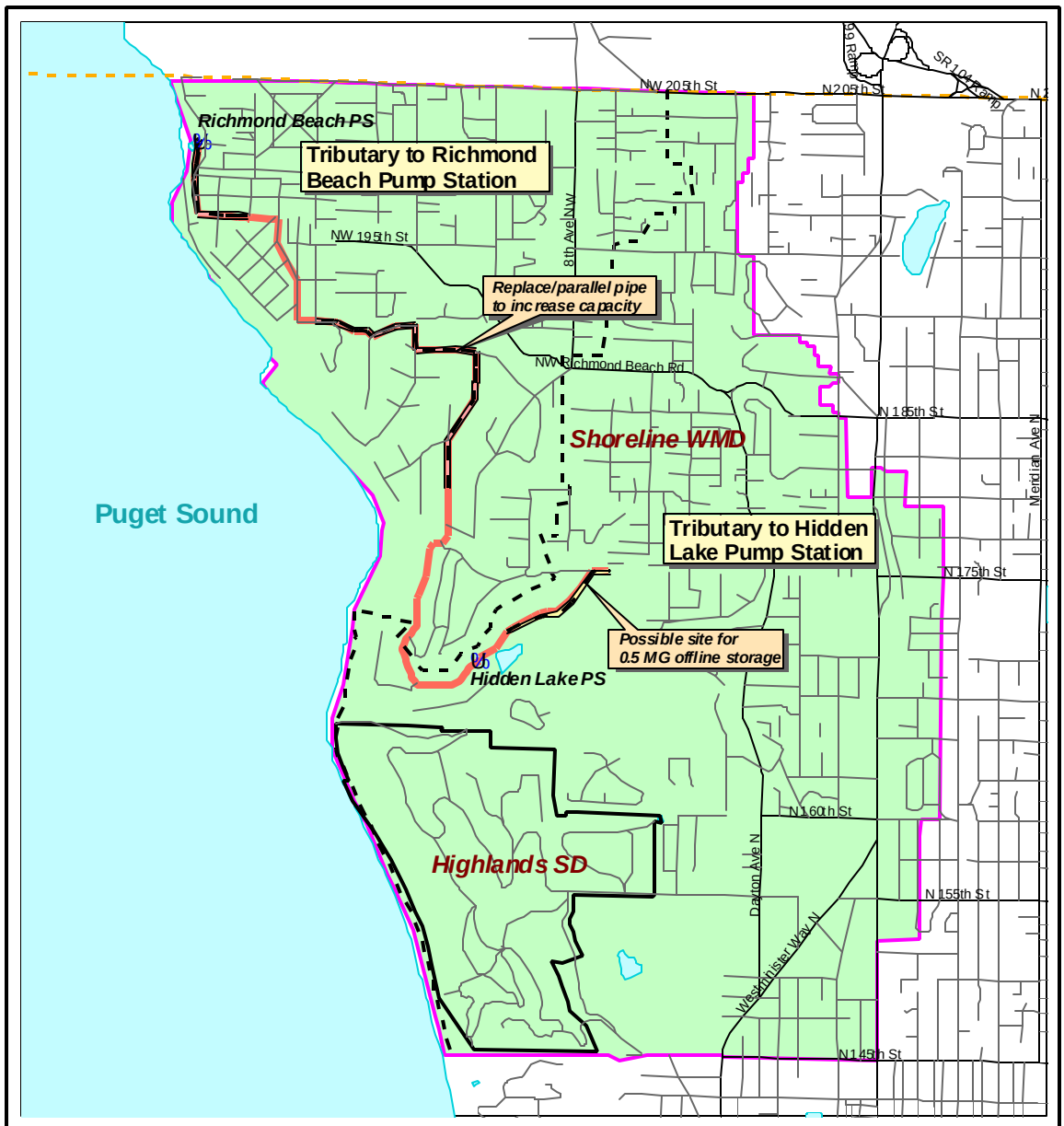
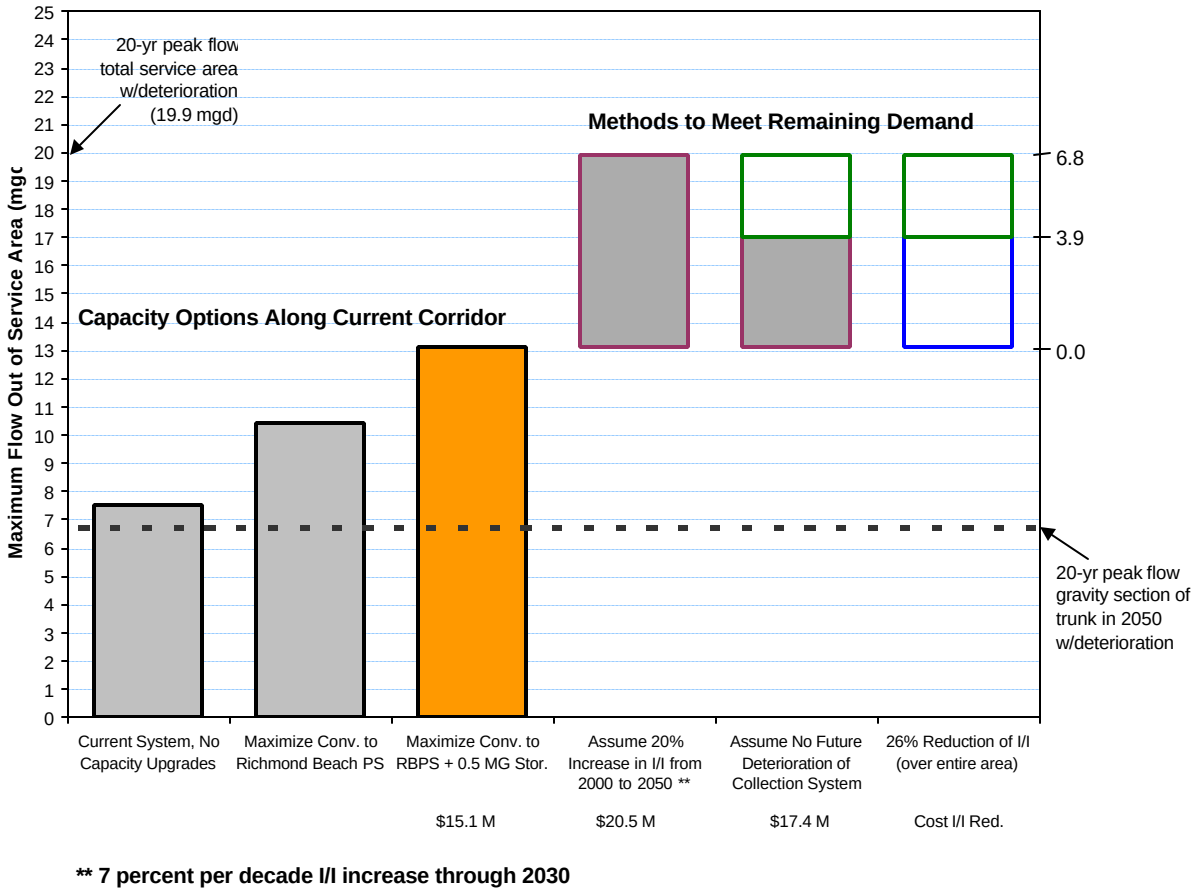


Figure 3: Working Alternative Phase I



**** 7 percent per decade I/I increase through 2030**

Figure 4. Distribution of costs for interim and future facilities upgrades in the Service Area